6. Noise Maintenance Limits for Unbundled Loops

6.01 Most unbundled loops have an associated noise maintenance limit. Noise, including noise resulting from crosstalk interference, is considered to be a trouble condition when the noise maintenance limit is exceeded. [2]

6.02 An unbundled loop will be maintained to the noise limit associated with the type of unbundled loop that was ordered.

6.03 The noise maintenance limits for the various types of unbundled loops offered by BA are shown in Table 6-1. Additional information may be found in the technical reference documents indicated in the table.

Table 6-1: Background Noise Limits for Unbundled Loops

Unbundled Loop Type	Bell Atlantic Reference	Noise Limit
2WA	TR 72565 [2]	30 dBrnC
2WACSS or 4WACSS	TR 72570 [4]	30 dBrnC
2WDI	TR 72575 [6]	28 dBrn (50 kb)
4WD1.5	TR 72575 [6]	None [3]
4WD56	TR 72575 [6]	28 dBrn (50 kb)
2WDH or 4WDH	TR 72575 [6]	28 dBrn (50 kb)
2WDA-R or 2WDA-C	TR 72575 [6]	28 dBrn (50 kb)

6.04 The frequency band associated with the noise maintenance limits correspond to the noise filters (C-Message and 50 kb) that are available on the test equipment used by BA technicians.

6.05 Noise filters for Basic Rate ISDN, HDSL, and ADSL technologies were developed when the IEEE-743 [23] standard was revised in 1995. These filters are not yet in general use throughout the industry. In addition, the industry has not yet developed corresponding loop noise performance criteria for use with these filters. When industry consensus is reached on the noise performance criteria for loops associated with Basic Rate ISDN, HDSL, and ADSL technologies, similar criteria will be developed for the unbundled 2WDI, 2WDH, 4WDH, and 2WDA loops.

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[2] It is possible to have interference when the noise limits are not exceeded however this will not be considered a trouble condition. In such instances, the CLEC may be able to improve the signal-to-noise ratio on the disturbed loop by increasing the signal amplitude as long as the maximum allowable signal power is not exceeded. In such instances however, it is likely that the CLEC has exceeded the viable loop range of the associated technology.

[3] A maximum noise parameter is not specified in Bell Atlantic TR 72575 [6] for the unbundled 4-Wire Digital DS1 loop. Performance is specified in terms of accuracy and availability.

7. Noise Mitigation Practices for Unbundled Loops

7.01 When the noise maintenance limit is exceeded on an unbundled loop, the CLEC is responsible for determining if the noise is in the CO or the loop.

A. Suitable Spare Pair Available

7.02 When the noise limit is exceeded on the metallic cable pair associated with an unbundled loop, BA will attempt to move the unbundled loop to a spare pair that meets the applicable noise limits (See Table 6-1), if such a pair is available.

7.03 When the unbundled loop is moved to an available spare pair that meets the applicable noise limits, the applicable assignment guidelines in Table 4-1 will be used, if feasible.

7.04 If a noise problem on an unbundled loop is known to be caused by an incompatible service/technology such as those described in Table 4-1, BA will decide whether to move the disturbed unbundled loop or the disturber service/technology. If the noise problem is caused by CLEC services or technologies including CPE, the CLEC is responsible for correcting the problem even if it includes taking down the loop. (BA would not want to commit to move service in this instance.) (Here we are talking about an unbundled loop that has a noisy pair. If the noise is due to a correctly ordered and correctly operating incompatible technology in the same binder group (whether it is BA retail or CLEC unbundled loop), we will attempt to mitigate the noise problem by moving either the disturber or the victim. Sometimes, people believe that we would only try to move the victim since they are the one that reported the trouble but that's not true. It may be easier to move the disturber so we reserve the right to do so. This means that even if you are following all of the rules, we have to move you to a different loop in order to resolve someone else's problem. The objective will be to resolve the problem as quickly as possible with the least disruption of service and the least amount of work. The decision will be based on the following criteria:

(1) The number of each type of service/technology that needs to be separated;
(2) The services/technologies that operate in the other cable or binder group; and,
(3) The availability of the involved services and technologies for turndown.

B. Suitable Spare Pair Not Available

7.05 When the noise limit is exceeded on the metallic cable pair associated with an unbundled loop and a suitable spare pair is not available, the noise on the disturbed unbundled loop should be analyzed by the CLEC to determine the source of the interference. The analysis can be performed with a spectrum analyzer. The frequency spectrum of the noise can often identify the type of service/technology that is the source of the crosstalk interference.

7.06 Impulse noise is often generated by sub-voice services. The CLEC and end-user customer should identify the types of sub-voice services that are used by the end-user.

7.07 If the problem is high frequency background noise, the CLEC and end-user customer should identify the types of high frequency services/technologies that are used by the end-user.

7.08 High frequency noise due to crosstalk interference on unbundled loops is likely to involve the following services/technologies (however other interference is possible):

(1) ADSL technology interfering with unbundled 4-Wire Digital DS1 loops that use T1 technology;

(2) T1 technology interfering with unbundled 2-Wire Digital ADSL-Qualified loops;
(3) HDSL technology interfering with unbundled 2-Wire Digital ADSL-Qualified loops;
(4) Unsupported ADSL applications interfering with unbundled 2-Wire Digital ADSL-Qualified loops; or,
(5) Supported ADSL applications interfering with unbundled 2-Wire Digital ADSL-Qualified loops.

7.09 If a suitable spare pair is not available and the source of the noise on the unbundled loop has been identified by the CLEC, BA will attempt to locate the disturber pair or pairs and will attempt to determine if it is feasible to move the disturber services/technologies to another cable or binder group. The decision to move the services/technologies on the disturber pairs will be based on the following criteria:

(1) The number of disturber circuits that need to be moved;
(2) The services/technologies that operate in the other cable or binder group; and,
(3) The availability of the involved services for turndown.

7.10 If the disturber pair or pairs are located, BA will attempt to determine if the applicable signal power limits in Section 3 are being met. If the associated signal power limits are exceeded, the service/technology will be discontinued to prevent further interference. The service/technology shall remain discontinued until the associated CPE or network equipment is made to conform with the applicable signal power limits or until the service/technology is permanently disconnected.

7.11 If the disturber pair or pairs are located and BA determines that the applicable signal power limits are being met, BA will attempt to determine if it is possible to decrease the signal amplitude on the disturber pair or pairs. A decrease in disturber signal power will usually increase the signal-to-noise ratio on the disturbed loop.

7.12 If the disturber pair or pairs are located and BA determines that the applicable signal power limits are being met and it is not possible to lower the signal power on the disturber loop or lowering the power on the disturber loop is not effective, BA will attempt to determine if suitable spare pairs exist in another binder group or cable to move the disturber service/technology. The decision to move the service/technology on the disturber pair or pairs will be based on the criteria in 7.10.

7.13 If the disturber pair or pairs are located and BA determines that the applicable signal power limits are being met and it is not possible to lower the signal power on the disturber loop or lowering the power on the disturber loop is not effective and the disturber service/technology cannot be moved to another binder group or cable, the facility augmentation procedures described in Section 5 are applicable to the disturbed unbundled loop.

7.14 If a suitable spare pair is not available and the source of the noise cannot be located, the facility augmentation procedures described in Section 5 are applicable.

C. Signal Power Limits Exceeded on Unbundled Loop

7.15 If the CLEC equipment or CPE connected to an unbundled loop exceeds the signal power limits for the type of unbundled loop that was ordered, the CLEC must cease and desist upon notification. When the CLEC equipment or CPE conforms to the applicable signal power limits for the type of unbundled loop that was ordered, the unbundled loop will be restored. BA reserves the right to disconnect any unbundled loop that causes such interference in the event that the CLEC does not act promptly to cease and desist such interference upon notification.

7.16 To prevent interference, the unbundled loops offered by BA may only be used with the specific type of technology for which the unbundled loop was intended. If interference occurs because a CLEC is exceeding the signal power limits for the type of unbundled loop that was ordered, the CLEC shall cease and desist the interference upon notification. When the CLEC conforms to the applicable signal power limits for the type of unbundled service that was ordered, the unbundled loop will be restored. BA reserves the right to disconnect any unbundled loop that causes such interference in the event that the CLEC does not act promptly to cease and desist such interference upon notification.

Table 4-1: Spectrum Management Assignment Guidelines for Unbundled Loops

(1) Unbundled Loop Service (ULS) Other Services and Technologies	2WA	2WACSS or 4WACSS	2WD56*	2WDI	4WD1.5 (using T1)	2WDH or 4WDH	2WDA
Sub-Voice	C(2)	C(2)	C(2)	C(2)	C(2)	C(2)	C(2)
Voice Grade 2WA ULS 2WACSS ULS 4WACSS ULS	C	C	C	C	C	C	C
P-Phone	C	C	C	C	C	C	C
15 kHz Program Audio	C	C	C	(3)	C	(3)	(3)
DDS Type I PSDS 4WD56 ULS	C	C	C	(4)	C	C	C
Type II PSDS Type III PSDS	C	C	C	(5)	C	(5)	(5)
LADC	C	C	C	C	C	C	C
LANGATE CO-LAN	C	C	C	(6)	(5)	(6)	(6)
Basic Rate ISDN 2WDI ULS	C	C	(4)	C	C	C	C
Analog Carrier	C	C	(7)	(7)	(7)	(7)	(7)
T1 4WD1.5 ULS (using T1)	C	C	C	C	C	C	(8)
DS1 using HDSL 2WDH ULS 4WDH ULS	C	C	C	C	C	C	C(9)
InfoSpeed DSL 2WDA-R ULS 2WDA-C ULS	C	C	C	C	(8)	(9)	C(10)

C = Compatible when assigned to pairs in the same binder group.

Notes:
(1) Other types of unbundled loops will be considered upon receipt of a bona fide request.
(2) If an impulse noise problem occurs, BA will attempt to find a spare pair that meets applicable impulse noise criteria.
(3) Separate binder groups often provide spectral compatibility. Non-adjacent binder groups preferred.
(4) Separate binder groups provide spectral compatibility for Extended Range DDS technology.
(5) Separate binder groups provide spectral compatibility.
(6) Separate binder groups provide compatibility when DVMs cannot be operated at < 80% of max range.
(7) Separate cables provide spectral compatibility.
(8) Separate non-adjacent binder groups provide spectral compatibility.
(9) HDSL may reduce the operating range of ADSL technology when both are in the same binder group.
(10) Compatible for supported ADSL applications. See 4.41 for a description of the ADSL applications that are not supported.

5. Facility Augmentation

5.01 The provisioning of unbundled loops is subject to the availability of existing suitable facilities on a first-come first-served basis.

5.02 Unbundled loop offerings do not create an obligation on the part of BA to construct a specific type of loop facility, such as a non-loaded metallic cable, in order to support a particular type of unbundled loop.

5.03 When an existing suitable facility is not available for a particular type of unbundled loop, the CLEC may choose to avail itself of BA's special construction services. We need to be careful here. We are not offering special construction services or the "build-out" of copper facilities to allow for the provision of xDSL services where copper facilities do not already exist. (Agreed. that's covered by the next paragraph.)

5.04 Metallic facilities are in decreasing supply because they are being replaced in many areas by fiber facilities. For this reason, no guarantee can be made that any metallic facility will continue to be available in the future. However, we do have notification requirements where advanced services are currently deployed. These requirements have been put in place by the FCC. (True, but no need to mantion that here.)

6. Noise Maintenance Limits for Unbundled Loops

6.01 Most unbundled loops have an associated noise maintenance limit. Noise, including noise resulting from crosstalk interference, is considered to be a trouble condition when the noise maintenance limit is exceeded. [2]

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6.04 The frequency band associated with the noise maintenance limits correspond to the noise filters (C-Message and 50 kb) that are available on the test equipment used by BA technicians.

6.05 Noise filters for Basic Rate ISDN, HDSL, and ADSL technologies were developed when the IEEE-743 [23] standard was revised in 1995. These filters are not yet in general use throughout the industry. In addition, the industry has not yet developed corresponding loop noise performance criteria for use with these filters. When industry consensus is reached on the noise performance criteria for loops associated with Basic Rate ISDN, HDSL, and ADSL technologies, similar criteria will be developed for the unbundled 2WDI, 2WDH, 4WDH, and 2WDA loops.

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[2] It is possible to have interference when the noise limits are not exceeded however this will not be considered a trouble condition. In such instances, the CLEC may be able to improve the signal-to-noise ratio on the disturbed loop by increasing the signal amplitude as long as the maximum allowable signal power is not exceeded. In such instances however, it is likely that the CLEC has exceeded the viable loop range of the associated technology.

[3] A maximum noise parameter is not specified in Bell Atlantic TR 72575 [6] for the unbundled 4-Wire Digital DS1 loop. Performance is specified in terms of accuracy and availability.

7. Noise Mitigation Practices for Unbundled Loops

7.01 When the noise maintenance limit is exceeded on an unbundled loop, the CLEC is responsible for determining if the noise is in the CO or the loop.

A. Suitable Spare Pair Available

7.02 When the noise limit is exceeded on the metallic cable pair associated with an unbundled loop, BA will attempt to move the unbundled loop to a spare pair that meets the applicable noise limits (See Table 6-1), if such a pair is available.

7.03 When the unbundled loop is moved to an available spare pair that meets the applicable noise limits, the applicable assignment guidelines in Table 4-1 will be used, if feasible.

7.04 If a noise problem on an unbundled loop is known to be caused by an incompatible service/technology such as those described in Table 4-1, BA will decide whether to move the disturbed unbundled loop or the disturber service/technology. If the noise problem is caused by CLEC services or technologies including CPE, the CLEC is responsible for correcting the problem even if it includes taking down the loop. (BA would not want to commit to move service in this instance.) (Here we are talking about an unbundled loop that has a noisy pair. If the noise is due to a correctly ordered and correctly operating incompatible technology in the same binder group (whether it is BA retail or CLEC unbundled loop), we will attempt to mitigate the noise problem by moving either the disturber or the victim. Sometimes, people believe that we would only try to move the victim since they are the one that reported the trouble but that's not true. It may be easier to move the disturber so we reserve the right to do so. This means that even if you are following all of the rules, we have to move you to a different loop in order to resolve someone else's problem. The objective will be to resolve the problem as quickly as possible with the least disruption of service and the least amount of work. The decision will be based on the following criteria:

(1) The number of each type of service/technology that needs to be separated;
(2) The services/technologies that operate in the other cable or binder group; and,
(3) The availability of the involved services and technologies for turndown.

B. Suitable Spare Pair Not Available

7.05 When the noise limit is exceeded on the metallic cable pair associated with an unbundled loop and a suitable spare pair is not available, the noise on the disturbed unbundled loop should be analyzed by the CLEC to determine the source of the interference. The analysis can be performed with a spectrum analyzer. The frequency spectrum of the noise can often identify the type of service/technology that is the source of the crosstalk interference.

7.06 Impulse noise is often generated by sub-voice services. The CLEC and end-user customer should identify the types of sub-voice services that are used by the end-user.

7.07 If the problem is high frequency background noise, the CLEC and end-user customer should identify the types of high frequency services/technologies that are used by the end-user.

7.08 High frequency noise due to crosstalk interference on unbundled loops is likely to involve the following services/technologies (however other interference is possible):

(1) ADSL technology interfering with unbundled 4-Wire Digital DS1 loops that use T1 technology;

(2) T1 technology interfering with unbundled 2-Wire Digital ADSL-Qualified loops;
(3) HDSL technology interfering with unbundled 2-Wire Digital ADSL-Qualified loops;
(4) Unsupported ADSL applications interfering with unbundled 2-Wire Digital ADSL-Qualified loops; or,
(5) Supported ADSL applications interfering with unbundled 2-Wire Digital ADSL-Qualified loops.

7.09 If a suitable spare pair is not available and the source of the noise on the unbundled loop has been identified by the CLEC, BA will attempt to locate the disturber pair or pairs and will attempt to determine if it is feasible to move the disturber services/technologies to another cable or binder group. The decision to move the services/technologies on the disturber pairs will be based on the following criteria:

(1) The number of disturber circuits that need to be moved;
(2) The services/technologies that operate in the other cable or binder group; and,
(3) The availability of the involved services for turndown.

7.10 If the disturber pair or pairs are located, BA will attempt to determine if the applicable signal power limits in Section 3 are being met. If the associated signal power limits are exceeded, the service/technology will be discontinued to prevent further interference. The service/technology shall remain discontinued until the associated CPE or network equipment is made to conform with the applicable signal power limits or until the service/technology is permanently disconnected.

7.11 If the disturber pair or pairs are located and BA determines that the applicable signal power limits are being met, BA will attempt to determine if it is possible to decrease the signal amplitude on the disturber pair or pairs. A decrease in disturber signal power will usually increase the signal-to-noise ratio on the disturbed loop.

7.12 If the disturber pair or pairs are located and BA determines that the applicable signal power limits are being met and it is not possible to lower the signal power on the disturber loop or lowering the power on the disturber loop is not effective, BA will attempt to determine if suitable spare pairs exist in another binder group or cable to move the disturber service/technology. The decision to move the service/technology on the disturber pair or pairs will be based on the criteria in 7.10.

7.13 If the disturber pair or pairs are located and BA determines that the applicable signal power limits are being met and it is not possible to lower the signal power on the disturber loop or lowering the power on the disturber loop is not effective and the disturber service/technology cannot be moved to another binder group or cable, the facility augmentation procedures described in Section 5 are applicable to the disturbed unbundled loop.

7.14 If a suitable spare pair is not available and the source of the noise cannot be located, the facility augmentation procedures described in Section 5 are applicable.

C. Signal Power Limits Exceeded on Unbundled Loop

7.15 If the CLEC equipment or CPE connected to an unbundled loop exceeds the signal power limits for the type of unbundled loop that was ordered, the CLEC must cease and desist upon notification. When the CLEC equipment or CPE conforms to the applicable signal power limits for the type of unbundled loop that was ordered, the unbundled loop will be restored. BA reserves the right to disconnect any unbundled loop that causes such interference in the event that the CLEC does not act promptly to cease and desist such interference upon notification.

7.16 To prevent interference, the unbundled loops offered by BA may only be used with the specific type of technology for which the unbundled loop was intended. If interference occurs because a CLEC is exceeding the signal power limits for the type of unbundled loop that was ordered, the CLEC shall cease and desist the interference upon notification. When the CLEC conforms to the applicable signal power limits for the type of unbundled service that was ordered, the unbundled loop will be restored. BA reserves the right to disconnect any unbundled loop that causes such interference in the event that the CLEC does not act promptly to cease and desist such interference upon notification.

8. Spectral Compatibility Analysis

8.01 Proposed new CLEC technologies that will be used with BA unbundled loops shall be spectrally compatible as a disturbing technology with all of the following services and technologies that are currently being used or are planned for deployment in BA subscriber loop cables:

- Voice Grade services;
- Digital Data Services and Type I PSDS services;
- Basic Rate ISDN services and technologies;
- T1 technology;
- HDSL technology;
- ADSL DMT technology; and,
- Single Carrier (CAP/QAM) RADSL technology (described in T1E1.4/98-294).

8.02 Proposed new CLEC technologies that will be used with BA unbundled loops can be expected to operate in a subscriber loop environment that includes the following services and technologies:

- Sub-voice services;
- Voice Grade services;
- P-Phone services;
- 15 kHz Program Audio services;
- Digital Data Services and Type I PSDS services (both normal and extended range);
- Type III PSDS (NTI Datapath);
- Local Area Data Channels;
- LANGATE services and CO-LAN technologies;
- Basic Rate ISDN services and technologies;
- Analog Carrier technologies;
- T1 technology;
- HDSL technology;
- ADSL DMT technology (described in T1.413); and,
- Single Carrier (CAP/QAM) RADSL technology (described in T1E1.4/98-294).

8.03 As a part of its spectrum management responsibilities BA must determine the extent to which all new loop technologies will interfere with all embedded and known future services and technologies. In addition, BA must determine the extent to which embedded and known future services and technologies will interfere with any proposed new loop technology. In order to make this determination, a spectral compatibility analysis must be performed.

8.04 It is the responsibility of the CLEC to perform a spectral compatibility analysis for all technologies that the CLEC proposes to use with BA unbundled loops. The methodology for the spectral compatibility analysis and an outline for the spectral compatibility report are described in this section. The CLEC shall submit the spectral compatibility analysis report to BA as a part of the technical documentation associated with a Bona Fide Request (BFR) when the CLEC proposes to deploy a technology that has specifications that are different than those associated with the BA unbundled loops defined in section 3A. (This information should be contained in the BFR section of the CLEC handbook; it currently is not. I will care for this action.) (Good idea. I thought Ms Pourdastian included a reference to this document in the BFR procedures.)

8.05 In addition to the spectral compatibility analysis report, the proposed new technology shall be made available to BA by the CLEC so that BA can perform lab or field tests to verify the findings of the spectral compatibility analysis report.

8.06 The determination of spectral compatibility between any two loop technologies can be achieved in two ways: from the results of a NEXT margin calculation and from the results of NEXT measurements. Since testing a system against all reasonable cases of interference on all reasonable loop configurations is not feasible, NEXT margin calculations are usually used since they provide flexibility for parameters like loop topology that can greatly influence the results of the study. NEXT measurements are generally used to add credibility and confidence to the results obtained from NEXT margin calculations .

A. Spectral Compatibility Analysis Report

8.07 The spectral compatibility analysis report shall provide technical information about the proposed new loop technology. The type of information is defined in Part A of the spectral compatibility report outline that is shown in Figure 8-1.

8.08 The spectral compatibility analysis report shall provide technical information about each of the technologies for which spectral compatibility with the proposed new technology was studied. The type of information is defined in Part B of the spectral compatibility report outline that is shown in Figure 8-2.

8.09 The spectral compatibility analysis report shall provide information about all preliminary PSD analyses and all detailed spectral compatibility analyses. The type of information is defined in Part C of the spectral compatibility report outline that is shown in Figure 8-2.

8.10 The worksheet shown in Figure 8-3 should be used to report the results of NEXT margin calculations and measurements.

B. Preliminary PSD Analysis

8.11 The first step in determining spectral compatibility is to determine the PSD of the proposed new technology and to compare it with the PSDs of all of the services and technologies listed in 8.01. The best source for the PSD is a measurement made in the laboratory. This requires a spectrum analyzer and a working model of the proposed new technology. The PSDs of the technologies listed in 8.01 are available from several sources.

8.12 If the PSD of the proposed new technology does not overlap with the PSDs of any of the services and technologies listed in 8.01, the proposed new technology will usually be considered spectrally compatible as a disturber technology with the services/technologies listed in 8.01.

8.13 If the PSD of the proposed new technology is confined entirely within the PSD of one of the service and technologies listed in 8.01, the proposed new technology will usually be considered to have the same spectral disturber characteristics as the particular service/technology that shares the same PSD.

8.14 For example, the proposed new technology will usually be considered spectrally compatible as a disturber technology with the T1, Basic Rate ISDN, HDSL, and ADSL technologies if it is shown that the transmit PSD of the proposed new technology is completely contained within the transmit PSD template of either Basic Rate ISDN technology (Figure 3-3) or HDSL technology (Figure 3-5).

8.15 Similarly, the proposed new technology will usually be considered spectrally compatible as a disturber technology with the Basic Rate ISDN, HDSL, and ADSL technologies if the transmit PSD of the proposed new technology in the downstream (CO to End-User) direction is within one of the ADSL downstream PSD templates (Figure 3-7 or 3-8), and the transmit PSD of the proposed new technology in the upstream direction is within the ADSL upstream PSD template (Figure 3-6).

8.16 If the preliminary PSD analysis of the proposed new technology reveals that the PSD overlaps the PSD of any of the technologies listed in 8.01, a detailed analysis shall be performed in order to determine spectral compatibility. A detailed analysis may also be needed to determine the spectral compatibility of the proposed new technology as a disturbed system.

C. Detailed Spectral Compatibility Analysis

8.17 The detailed spectral compatibility analysis explores the NEXT compatibility of the proposed new technology with the services and technologies listed in 8.01 that have a PSD that overlaps the PSD of the proposed new technology.

8.18 NEXT margin calculations and PSD measurements shall be made for both the downstream and upstream signals for services or technologies that use different transmit and receive frequency spectrums.

8.19 NEXT margin calculations are used to determine the amount of operating margin (in dB) for a potentially disturbed technology when the proposed new technology acts as a potential disturber. In addition, NEXT margin calculations are used to determine the amount of operating margin for the proposed new technology when the technologies listed in 8.01 that have a PSD that overlaps the PSD of the proposed new technology act as potential disturbers.

D. NEXT Margin Calculations

8.20 NEXT margin is a function of several variables. The NEXT margin for a simple technology is determined by subtracting the minimum signal to noise ratio of the potentially disturbed technology, the power of the NEXT generated by the potential disturber technology, and a safety factor for uncharacterized impairments from the minimum receive signal power of the potentially disturbed technology.

8.21 Each of the factors mentioned above depends upon other variables. For example, the receive signal power depends upon the PSD of the transmitted signal from the potentially disturbed technology, the loss characteristics of the maximum loop upon which the potentially disturbed system can be deployed, and the receiver filter of the potentially disturbed technology. Likewise, the characteristics of the NEXT coupling path, the PSD of the transmitted signal from the disturber technology, and the receiver filter of the disturbed technology determine the power of the NEXT.

8.22 For high frequency applications, at least five types of computations should be considered: T1, Basic Rate ISDN, 2B1Q HDSL, CAP/QAM RADSL, and DMT ADSL. The actual computations to be used depends on the technologies being affected not the new technology.

8.23 The spectral compatibility analysis calculations shall determine the NEXT margin by using the Bellcore 1% worst case NEXT statistical exposure model for a 50 pair binder group with 49 disturbers. The calculations shall use 6dB as the safety factor for uncharacterized impairments. The use of NEXT statistical exposure models is explained in Section 8I and the safety factor for uncharacterized impairments is described in Section 8H.

8.24 The spectral compatibility analysis report shall provide the results (in dB) of NEXT margin calculations. The NEXT margin is a function of several variables. Most important among these are the characteristics of the NEXT coupling path, the loss characteristics of the loop on which the disturbed system is deployed, the characteristics of the transmitted signals of both the disturbed and disturber systems, and the receiver technology of the disturbed system. All of these variables must be explained in the spectral compatibility analysis report.

8.25 The complexity of the receiver structure determines the level of computer modeling required for meaningful results. The spectral compatibility analysis reduces to a comparison of the NEXT interference and received signal power sums at the front end of the disturbed receiver. In that analysis, the front end filter in the disturbed receiver determines the bandwidth over which the NEXT interference and received signal power sums are calculated.

8.26 The formula used to calculate the NEXT margin in these simple cases is:

MARGIN = P_{rx} - SNR_{min} - P_{next} - 6 dB

where;

P_{rx} = the received signal power at the front end of the disturbed receiver,
SNR_{min} = the minimum signal to noise ratio at the front end [illegible]equired by the disturbed receiver,
P_{next} = the NEXT power at the front end of the disturbed receiver, and
6 dB = the margin requirement for uncharacterized impairments.

E. Received Signal Power (P_{rx})

8.27 The received signal power is the total signal power passed through the front end filter of the disturbed receiver. The PSD of the received signal is obtained by adding the transmitted PSD of the disturbed system and the loss characteristic of a loop. A power sum of the received PSD over the bandwidth of the front end filter of the disturbed receiver derives the received signal power.

F. Minimum Required Signal to Noise Ratio (SNR_{min})

8.28 The minimum required signal to noise ratio applies to the front end of the disturbed receiver. It is the ratio of the instantaneous received signal power at the front end of the disturbed receiver to the rms value of random (white) noise that will yield a specified bit error rate at the output of the receiver.

8.29 The SNR_{min} value may be obtained in two ways: by direct measurement or from a manufacturer's specifications. To obtain the SNR_{min} from measurement, white noise is introduced at the front end of the disturbed system's receiver via a balanced, high-impedance bridging network. The level of white noise is then varied until a specified bit error rate is achieved at the receiver output. Once the received signal power is measured, the minimum required signal to noise ratio can be calculated.

8.30 The SNR_{min} is a simple way to account for the signal processing that occurs in the disturbed receiver. For systems with complex receiver structures however, such as adaptive equalizers, more accurate results can be obtained if the signal processing is simulated so that the effect of the NEXT interference is observed at the decision logic. For most TCM systems however, the low complexity receiver structure of the disturbed system adequately ensures that the use of the SNR_{min} will generate a comfortable accuracy in the margin calculation.

G. Near End Crosstalk Power (Pnext)

8.31 The NEXT power is the total power from a specified number of disturbers that is passed through the front end filter of the disturbed receiver. It is determined from the spectrum of the output signal from the disturber transmitter and the crosstalk transfer function of the NEXT model. The PSD of the NEXT is obtained by adding the PSD of the output signal from the disturbed transmitter and the PSD of the crosstalk transfer function. This PSD represents the NEXT interference from a specified number of disturbers coupled into the loop in which the disturbed system is operating. A power sum of the NEXT PSD over the bandwidth of the front end filter of the disturbed receiver derives the NEXT power.

H. Safety Factor for Uncharacterized Impairments

8.32 An additional safety factor shall be incorporated into NEXT margin calculations to account for known impairments that have not been characterized. Calculations shall use a 6 dB safety factor.

I. NEXT Statistical Exposure Models

8.33 It is impossible to predict just what the spacing between two pairs in a binder group will be over any practical length of cable. Since there are a certain number of pairs in a binder group however, it is possible to produce a statistical model of the amount of exposure between two pairs in the same binder group.

8.34 The NEXT statistical exposure model used in NEXT margin calculations is based on randomly selecting a disturbed pair in a cable and measuring the coupling from other pairs in the binder group. The NEXT power is determined for each selection of a disturbed pair and a combination of disturbing pairs. These NEXT powers are then assembled to form a distribution curve of NEXT powers. The upper end of the distribution curve represents the worst levels of NEXT; for example, the 1% level is that amount of NEXT that is greater than 99% of all the power levels used to draw the curve.

8.35 The smaller the percentage, the greater the assumed NEXT exposure level and the greater the NEXT. The Bellcore 1% NEXT statistical exposure model shall be used for detailed spectral compatibility analysis of new technologies that are proposed for use in the BA loop environment.

8.36 The Bellcore 1% NEXT statistical exposure model is given in Bellcore TM-TSY-000645 [24]. The NEXT statistical exposure model is a NEXT transfer function that is defined as the magnitude of the 1% NEXT loss in dB, versus the frequency in Hz. The model is also a function of the number of disturbers which can very from a minimum of one to a maximum of forty-nine.

8.37 Exposure varies when the number of pairs that act as sources for the crosstalk signal are changed. As the number of pairs carrying a disturbing signal increases, the amount of crosstalk power in the disturbed pair increases. The detailed spectral compatibility analysis shall assume a 50 pair binder group with 49 disturbers.

8.38 In some cases, it may be valid to reduce the number of disturbers in the analysis. If the number of disturbers is reduced, a rationale shall be provided by the CLEC in the spectral compatibility report furnished to BA. In no case however, shall the number of disturbers be less than 10.

J. Obtaining Transmit PSDs

8.39 There are two methods for obtaining the transmit PSD of a technology: from measurement or from an equation that represents a technologies transmit PSD. To measure the transmitted PSD, a spectrum analyzer is bridged across the system via a balanced high impedance network.

8.40 For some technologies, such as T1 and Basic Rate ISDN, equations for the PSD of the transmitted signal have been developed. These PSDs are a function of the particular line code used by the technology.

K. Crosstalk Transfer Function

8.41 The crosstalk transfer function can be calculated for a number of disturbers ranging from a minimum of one to a maximum of forty-nine. The crosstalk transfer function and the transmit PSD of a system are used to derive the NEXT power (Pnext) from a specified number of disturbers.

L. Interpretation of NEXT Margin Results

8.42 A zero or positive NEXT margin indicates that the combination of disturber and disturbed technologies is spectrally compatible. The received power of a disturbed system is greater than the NEXT interference by an amount greater than or equal to the required minimum signal to noise ratio plus 6 dB.

8.43 A negative NEXT margin indicates potential crosstalk problems between the combination of disturber and disturbed technologies because the NEXT interference is greater than the maximum noise power permitted at the front end of the disturbed receiver. The maximum noise power is a function of the received signal power, the minimum required signal to noise ratio, and the 6 dB factor for uncharacterized impairments.

8.44 Margins generated using the 1% NEXT model with 49 disturbers are valuable in analyzing a technologies potential for ubiquitous deployment. Such a deployment scenario implies that little or no engineering administration or maintenance is required to deploy a technology. The existence of negative NEXT margins using the 1% NEXT, 49 disturber model suggests that ubiquitous deployment may not be realizable. This does not imply that the technology is non-deployable.

M. Reducing Operating Range to Achieve Compatibility

8.45 When services or technologies are not fully compatible with other services or technologies, they can often be made compatible by restricting the conditions of their deployment. One of the most useful restrictions is reducing the range of operation.

8.46 The range of a service/technology is the maximum distance that a service/technology may be deployed from the CO as measured by the loss (attenuation) of the transmitted signal. By restricting the operating range, the amount of signal attenuation is reduced and thus the signal at the receiver is stronger. The stronger signal improves the signal to NEXT noise ratio.

8.47 The CLEC shall identify all situations where the range of the proposed new technology was restricted in order to achieve compatibility with a particular technology. The range of embedded technologies will not normally be reduced in order to support proposed new technologies.

Figure 8-1. Spectral Compatibility Report Outline (page 1 of 2)

A. Description of proposed new technology

1. Technical description
    a. Type of operation (e.g., simultaneous voice and full duplex data, etc.)
    b. Transmission technique
    c. Description of interfaces
    d. Type of loop
    e. Data and baud rates
    f. Minimum bit error rate
    g. Modes of operation
    h. Optional features
    i. Type of protection for power fault in equipment
    j. Type of protection for power or lightning surge
    k. Power specifications
    l. Maximum Tip-ground, ring-ground, and tip-ring voltages

2. Method for obtaining the PSD (See section 8J)

3. Transmit signal specifications
    a. Transmit PSD
    b. transmitter impedance
    c. isolated pulse waveform
    d. total transmitted power
    e. transmitted pulse height

4. Model used for transceiver
    a. filters
    b. pre-equalizers
    c. equalizers
    d. echo cancellers
    e. coupling networks

5. Maximum operating range.
    a. Maximum bridged tap length
    b. Worst-case bridged tap length
    c. Maximum loop length
    d. Loop topology used for analysis
    e. Method of calculating loss characteristics of loop

6. Minimum signal to noise ratio

7. Formula used for calculation of crosstalk transfer function
    a. Identify Percent of Disturbers
    b. Identify Number of Disturbers

8. NEXT Margin Calculation Formula
    (Proposed new technology as potential disturbed technology.)

(Trone, these items are probable included or implied in some of the language here, but does this outline care for things like 1) the type of facility that the new service/technology can work on? (Yes, implied in 5d) 2) what the impacts/limitations are in regards to electronics (i.e., mid-spans, pair-gain, etc,) (Yes, implied in 1a) and 3) bandwidth?) (Yes, in 3a)

Figure 8-2. Spectral Compatibility Report Outline (page 2 of 2)

B. Description of Other Technology

1. Technical description
    a. Type of operation
    b. Transmission technique
    c. Description of interfaces
    d. Type of loop
    e. Data and baud rates
    f. Minimum bit error rate
    g. Modes of operation
    h. Optional features

2. Method for obtaining the PSD (See section 8J)

3. Transmit signal specifications
    a. Transmit PSD
    b. transmitter impedance
    c. isolated pulse waveform
    d. total transmitted power
    e. transmitted pulse height

4. Model used for transceiver
    a. filters
    b. pre-equalizers
    c. equalizers
    d. coupling networks

5. Maximum transmission range.
    a. Loop topology used for analysis
    b. Method of calculating loss characteristics of loop

6. Minimum signal to noise ratio

7. Formula used for calculation of crosstalk transfer function
    a. Identify Percent of Disturbers
    b. Identify Number of Disturbers

8. NEXT Margin Calculation Formula
    (Other technology as potential disturbed technology.)

C. PSD Analysis and NEXT Margin Calculations
1. Preliminary PSD analyses
2. NEXT Calculations
3. Results of NEXT Margin Calculations
4. Results of NEXT Measurements
5. Interpretation of Results
6. Proposed reductions in the deployment ranges of disturbed systems

Figure 8-3. NEXT Margin Worksheet for Loop Technologies Deployed at Maximum Range with Proposed New Technology as the Disturbing and Disturbed System

Other Loop Technology	Center Frequency (kHz)	Maximum Loop Loss (dB)	Margin with Proposed New Technology as Disturbing System (1)	Margin with Proposed New Technology as Disturbed System (1)
Sub-Voice	1	10		
* Voice Grade	1	10		
P-Phone	8	24		
15 kHz Audio	7.5	32		
* DDS/Type I PSDS (2)	28	34		
* DDS Ext Range (3)	28	45		
Type II PSDS (4)	72	45		
Type III PSDS (5)	80	45		
LADC (6)				
CO-LAN (7)	114	52		
CO-LAN (8)	80	40		
* Basic Rate ISDN (9)	40	42		
SLC-1 ACXR	76	53		
CM-8 ACXR	82	40		
* T1	772	32		
* HDSL (10)	196	35		
* RADSL-CAP (11)				
* ADSL-DMT (12)				

* Compatibility with these technologies is mandatory.

Notes:
1. Enter the margin values for technologies that overlap the transmit PSD of the proposed new technology. For technologies that do not overlap the transmit PSD, enter NA (not applicable).
2. ADTRAN OCU-DP in the normal range mode.
3. ADTRAN OCU-DP in the extended range mode.
4. Type II Public Switched Digital Service = AT&T CSDC.
5. Type III Public Switched Digital Service = NTI Datapath
6. Limited distance modem conforming to Bell System PUB 41028 [21].
7. GDC DTX-2010
8. Lear Siegler VAD 9600 - Long Loop Mode
9. Basic Rate ISDN PSD is described in Annex B of T1.413-1995 [12].
10. HDSL PSD is described in Annex B of T1.413-1995 [12].
11. RADSL-CAP PSD is described in T1E1.4/98-294 [13].
12. Frequency division multiplexing (FDM) system conforming to T1.413-1995 [12].

9. References

A. Definitions

Analog Unbundled Loop Service with Customer Specified Signaling (AULSCSS)
The former name for the Unbundled 2-wire Analog Loop with Customer Specified Signaling and the Unbundled 4-wire Analog Loop with Customer Specified Signaling.

Asymmetrical Digital Subscriber Line (ADSL)
A transmission system that is capable of transmitting digital signals at different upstream and downstream rates on the same loop as POTS. Standard ADSL systems use the Discrete Multitone (DMT) line code.

Basic Link
The former name for the unbundled 2-wire analog loop in New York and New England.

Basic Unbundled Loop Service (BULS)
The former name for the unbundled 2-wire analog loop service in the District of Columbia, Delaware, Maryland, New Jersey, Pennsylvania, Virginia, and West Virginia.

Binder Group
A cluster of twisted pairs in a multi-pair cable that are twisted together as a single unit. The number of pairs in a binder group depending upon the type of cable and the total number of pairs in the cable.

Carrierless Amplitude and Phase Modulation (CAP)
An ADSL line code technique that maps serial bits into phase and quadrature symbols and uses a filter to provide passband spectral shaping.

Central Office (CO)
A telephone company building which houses equipment and facilities used to provide switched access services.

Certified Local Exchange Carrier (CLEC)
An organization that has been certified to provide telecommunications services to the public.

C-Message Noise
The frequency-weighted, short-term average noise within an idle channel. The frequency weighting, called C-message, is used to account for the variations in 500-type telephone set transducer efficiency and EU annoyance to tones as a function of frequency.

Crosstalk
Noise and interference caused when signals on disturber pairs in the same cable couple into the disturbed pair.

Customer Premises Equipment (CPE)
All of the cabling and equipment on the end-user customer's side of the network interface device or rate demarcation point.

dBm
A unit for expression of power level in decibels relative to one milliwatt.

dBrn
A unit used to express noise power in decibels relative to one picowatt (-90 dBm).

dBrnC0

Noise power in dBrnC referred to, or measured at, a zero transmission level point (0TLP).

Decibel (dB)
The logarithmic unit of signal power ratio most commonly used in telephony. It is used to express the relationship between two signal powers, usually between two acoustic, electric, or optical signals; it is equal to ten times the common logarithm of the ratio of the two signal powers.

Digital Data Service (DDS)
A service that permits the transmission of synchronous data, in a digital form, in both directions simultaneously (full duplex) at 64 kbps and subrates.

Digital Signal Level One (DS1)
A digital signal transmitted at the nominal rate of 1.544 Mbit/s. Mbps. (Thanks, I think I use Mbps everywhere else.)

Discrete Multitone (DMT)
An ADSL line code that is a version of multi-carrier modulation that allows allocation of physical payload data bits and perhaps transmitter power among many subchannels depending on the loss and interference encountered.

Drop Wire
The last portion of many subscriber loops that connects the distribution cable to the customer premises. The most common aerial drop wire (F-type) has parallel 18 ½ gauge steel conductors that are not twisted. Drop wires are usually less than 700 feet and less than 25 ohms.

Digital Signal Cross-Connect Level One (DSX-1)
A mechanical DS1 cross-connect frame where +/- 3 volt bipolar AMI signals are interconnected.

Far-End Crosstalk (FEXT)
The total crosstalk power measured at the far end of a channel.

High-Bit-Rate Digital Subscriber Line (HDSL)
A system that is capable of transmitting bi-directional DS1 (1.544 Mbps) signals or bi-directional half DS1 (768 kbps) signals over metallic twisted-pair cables to provide access to digital telecommunications services.

Infospeed DSL
Infospeed DSL is a high-speed data access service offered by Bell Atlantic. It works simultaneously with POTS on an existing loop. Infospeed DSL is based on two types of ADSL technologies: single carrier Rate Adaptive Asymmetric Digital Subscriber Line (RADSL) and Discrete Multi-Tone (DMT) ADSL.

Integrated Services Digital Network (ISDN)
ISDN describes the end-to-end digital telecommunications network architecture, which provides for the simultaneous access, transmission , and switching of voice, data, and image services. These functions are provided via channelized transport facilities over a limited number of standard user-network interfaces.

Loop
A transmission channel between a EU customer location and a BA CO that is used as a transmission channel for telephone company services.

Near-End Crosstalk
The total crosstalk power measured at the near end of a channel.

Network Interface Device (NID)

The connector (jack) installed by a carrier at the Rate Demarcation Point (RDP) which physically becomes the network to End-User customer interface. The term NID also refers to the apparatus that contains the network interface connector.

Noise
Interference or unwanted signals on a loop which can be the result of proximity to other lines or electrical devices, transmission of other electrical devices sharing the same loop, or the result of network equipment or CPE.

Plain Ordinary Telephone Service (POTS)
The basic single line switched access service offered by local exchange carriers to residential and business customers. POTS uses loop-start signaling.

Power Spectral Density (PSD)
The frequency content of a transmitted signal.

Premium Link
The former name for the unbundled 2-wire digital ISDN-qualified loop in New York and New England.

Rate Adaptive Digital Subscriber Line (RADSL)
A type of ADSL transmission system that is capable of transmitting digital signals at different upstream and downstream rates on the same loop as POTS. One difference between RADSL systems and standard ADSL systems is that RADSL systems use the CAP or QAM line codes described in T1E1.4/98-294R1.

Rate Demarcation Point (RDP)
The point at which Bell Atlantic network access recurring charges and responsibility stop and beyond which customer responsibility begins. The RDP is the point of demarcation and/or interconnection between a Bell Atlantic subscriber loop facility and EU premises cabling or terminal equipment. Bell Atlantic facilities at, or constituting, the rate demarcation point shall consist of wire or a jack conforming to Subpart F of Part 68 of FCC Rules.

Spectral Compatibility
The capability of two technologies to operate in the presence of crosstalk noise from each other.

Spectrum Management
An administrative process consisting of signal power limits, loop assignment guidelines, and spectral compatibility evaluation procedures that are intended to minimize the potential for interference in multi-pair cables.

Unbundled Loop
A transmission channel between a EU customer location and a LEC CO that is not a part of, or connected to, other LEC services.

Unbundled 2-Wire Analog (2WA) Loop
An effective 2-wire transmission channel between a end-user customer location and a LEC CO that is not a part of, or connected to, other LEC services. An unbundled 2WA loop is suitable for the transport of voicegrade analog signals and loop start signaling. In the past, the unbundled 2WA loop was known as Basic Unbundled Loop Service (BULS) and Basic Link.

Unbundled 2-Wire Analog Loop with Customer Specified Signaling (2WACSS)
An effective 2-wire transmission channel between a end-user customer location and a LEC CO that is not a part of, or connected to, other LEC services. An unbundled 2WACSS loop is suitable for the transport of voicegrade analog signals and the type of channel supervisory signaling that is specified by the CLEC at the time the service is ordered. In the past, the unbundled 2WACSS loop was known as Analog Unbundled Loop Service with Customer Specified Signaling (AULSCSS).

Unbundled 4-Wire Analog Loop with Customer Specified Signaling (4WACSS)
A 4-wire transmission channel between a end-user customer location and a LEC CO that is not a part of, or connected to, other LEC services. An unbundled 4WACSS loop is suitable for the transport of voicegrade analog signals and the type of channel supervisory signaling that is specified by the CLEC at the time the service is ordered. In the past, the unbundled 4WACSS loop was known as Analog Unbundled Loop Service with Customer Specified Signaling (AULSCSS).

Unbundled 2WDA-C Loop
An unbundled 2-wire non-loaded loop that is 12 kft or less and is suitable for the transport of ADSL or RADSL signals. The actual data rate on a particular unbundled 2WDA-C loop depends upon the performance of CLEC and EU-provided modems with the electrical characteristics (length, bridged tap, noise, etc.) associated with the loop.

Unbundled 2WDA-R Loop
An unbundled 2-wire non-loaded loop that is 18 kft or less and is suitable for the transport of ADSL or RADSL signals. The actual data rate on a particular unbundled 2WDA-R loop depends upon the performance of the CLEC and EU-provided modems with the electrical characteristics (length, bridged tap, noise, etc.) associated with the loop.

Unbundled 2-Wire Digital ADSL-Qualified (2WDA) Loop
An unbundled non-loaded loop that provides an effective 2-wire channel that is suitable for the transport of ADSL or RADSL signals between the Bell Atlantic central office distributing frame termination of collocated equipment belonging to a CLEC and the rate demarcation point at a customer location. Two types of unbundled non-loaded 2-wire ADSL-qualified loops are offered: the unbundled 2WDA-R loop that is 18 kft or less and the unbundled 2WDA-C loop that is 12 kft or less.

Unbundled 2-Wire Digital ISDN-Qualified (2WDI) Loop
An unbundled loop that provides an ISDN basic rate channel between the Bell Atlantic central office distributing frame termination of collocated equipment belonging to a CLEC and the rate demarcation point at a customer location. The channel is suitable for the transport of 160 kbps digital signals in both directions simultaneously using the 2B1Q line code described in ANSI T1.601-1992 [5].

Unbundled 2-Wire or 4-Wire Digital HDSL-Qualified Loop
An unbundled loop that provides either a 2-wire or 4-wire channel that is suitable for the transport of High-Bit-Rate Digital Subscriber Line signals between the Bell Atlantic central office distributing frame termination of collocated equipment belonging to a CLEC and the network interface device at a customer location. Two types of unbundled HDSL-Qualified loops are offered: 2WDH or 4WDH. An unbundled 2WDH loop provides the CLEC with a channel that is suitable for the transport of 784 kbps digital signals simultaneously in both directions. An unbundled 4WDH loop provides the CLEC with a channel that is suitable for the transport of 1.568 Mbps digital signals simultaneously in both directions. Unbundled 2WDH and 4WDH loops are suitable for the transport of 2B1Q signals as described in Committee T1 Technical Report No. 28 [10].

Unbundled 4-Wire Digital DS1 (4WD1.5) Loop
An unbundled loop that provides a 4-wire channel that is suitable for the transport of 1.544 Mbps (DS1) digital signals in both directions simultaneously between the Bell Atlantic central office DSX-1 termination of collocated equipment belonging to an CLEC and the network interface device at a customer location. The unbundled 4WD1.5 loop may be provided using a variety of loop transmission technologies however in this document metallic cable or a repeatered T1 metallic cable is assumed.

Unbundled 4-Wire Digital 56 kbps DDS (4WD56) Loop
An unbundled loop that provides a 4-wire channel that is suitable for the transport of Digital Data Service signals at 56 kbps between the Bell Atlantic central office distributing frame termination of collocated equipment belonging to a CLEC and the network interface device at a customer location. An optional

secondary channel operating at 8 kbps is available. In addition, an unbundled 4WD56 loop may be used to transport 56 kbps Type I Public Switched Digital Service (PSDS).

Voice Grade (VG)
A term used to describe a channel, circuit, facility, or service that is suitable for the transmission of speech, digital or analog data, or facsimile, generally with a frequency range of about 300 to 3000 Hz.